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Economic Globalization, Export Diversification and Greenhouse Gas Emissions: Evidence from OECD Countries

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Abstract

Global warming increases the pressure on our world as greenhouse gases accumulate in the atmosphere. By implementing more environmentally friendly technologies, we will be able to eliminate this destruction caused by our economic activities. This study examines the impact of economic globalization and export diversification on environmental degradation. The expansion of international trade and the integration of countries into world markets are indisputable aspects of this discussion. There are those who believe that trade has a negative impact on the environment, while others believe that transforming trade improves the quality of the environment. In this study, the research question is applied to the OECD for the period 1995-2019, and empirical analysis is conducted using panel data methods. This study reveals a negative relationship between export diversification and greenhouse gas emissions. Thus, increasing the diversity of commodities in the export basket positively affects environmental quality regardless of how much trade volume changes. A positive result does not only indicate an expansion of export baskets for each country but also suggests the spread of eco-innovative technological advances across all sectors and the development of a green economy. Moreover, other findings suggest that globalization, growth, and trade openness are not statistically significant.

Keywords: globalization, export diversification, global warming, trade openness.
Jel Codes : F13, F64, Q56.

Ekonomik Küreselleşme, İhracat Çeşitlendirmesi ve Sera Gazları Emisyonu: OECD Ülkelerinden Kanıtlar

Özet

Atmosferde biriken sera gazı miktarı arttıkça küresel ısınma, iklim değişikliği tehlikesinin dünyamız üzerindeki baskısını artırmaktadır. Ekonomik faaliyetlerimizin neden olduğu bu yıkımın giderilmesi, ekonomik yapının daha çevre dostu teknolojilerle dönüştürülmesine bağlıdır. Bu kapsamda çalışma ekonomik küreselleşmenin ve ihracat çeşitlendirmesinin çevresel bozulmalar üzerindeki etkisini analiz etmektedir. Bu tartışma yapılırken ülkelerin dünya piyasalarına entegre olması ve uluslararası ticaretin genişlemesi kaçınılmazdır. Ticareti bazı araştırmacılar çevre için zararlı bulurken diğer araştırmacılar dönüşen ticaretin çevre kalitesini artırdığını belirtmektedir. Bu çalışma, araştırma sorusunu OECD ülkeleri için 1995-2019 dönemini kapsayacak şekilde sormakta ve ampirik analizi panel veri metodolojisi kullanarak gerçekleştirmektedir. Çalışmanın bulguları ihracat çeşitlendirmesi ile sera gazları emisyonu arasında negatif ilişki tespit etmiştir. Buna göre ticaret hacmindeki değişimden bağımsız olarak, ihracat sepetindeki ticari ürün çeşidinin artması çevre kalitesini olumlu yönde etkilemektedir. Bu sonuç tek başına her ülkenin ihracat sepetini genişletmesi anlamına gelmemekte, aynı zamanda eko-yenilikçi teknolojik ilerlemelerin tüm sektörlere yayılmasına ve yeşil ekonominin ilerlemesine işaret etmektedir. Diğer bulgulara göre küreselleşme, büyüme ve ticari açıklık istatistiki olarak anlamlı faktörler değildir.

Anahtar Kelimeler: küreselleşme, ihracat çeşitlendirmesi, küresel ısınma, ticari açıklık.
Jel Kodları: F13, F64, Q56.

Araştırma ve Yayın Etiği Beyanı	Etik kurul kararı gerektirmemektedir.
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1. Introduction

A key aspect of climate change is the fact that our world is going through an irreversible process. In this process, countries focus on maintaining their economic growth while trying to minimize environmental degradation. Ongoing international efforts, such as the Paris Climate Agreement and the Sustainable Development Goals, are an attempt to find a way out for humanity in the context of the conflict between economic growth and the environment. The success of these attempts depends on countries working together on plans to reduce global warming (Levin et al., 2012). In the absence of action to address environmental degradation, factors such as climate change, desertification, and marine pollution will have a profoundly negative impact not only on our economies but also on the health of all life on earth. The Organization for Economic Co-operation and Development (OECD), one of the world's most influential organizations, should also take action to resolve this issue in partnership (Puertas and Marti, 2021).

According to World Bank (WB) statistics, the OECD countries produce 59.6% of the world's real gross domestic product (GDP) in 2022. The organization's share of world trade is 58.8% as well. In the mid-1990s, these two shares were 76.7% and 74.5% respectively. The main reason for this decline is the emergence of rapid-growing Asian economies, especially China and India. An important consequence of the declining share of the OECD members in total world output and trade is the fall in the organization's share of greenhouse gas (GHG) emissions. The organization's share of total GHG emissions declined from 46.2% in 1995 to 29.3% in 2020. The most polluting countries among the members are the United States (US), Japan, and Germany, respectively. When comparing 1995 with 2020, the share of the US in total GHG emissions in the world decreased from 19.3% to 11.9%, Japan's share from 4% to 2.3% and Germany's share from 3.2% to 1.5%. In the same period, the share of GHG emissions among members decreased for all countries except Türkiye (World Bank, 2023a, 2023b, 2023c). The declining role of OECD countries in causing pollution is not solely due to their shrinking share of production and trade. There is a direct and joint impact of economic growth, industrial structure, and technological development on emissions.

Depending on this fact the role of economic globalization via international trade in global warming has received increased attention across several disciplines in recent years as well. This study focuses on exports as one of the possible sources of global warming. Recent studies have discovered some links between export diversification and environmental degradation. However, this study contributes to the literature for the following reasons. Firstly, while many studies use CO2 as a proxy variable for pollution, this study used greenhouse gases, which encompasses a broader range of pollution. Second, we utilize the de jure component of the economic globalization index. Furthermore, although most studies use the Theil index for export diversification, this study incorporates a variable adapted from UNCTAD's Finger-Krenin index. As a final point, the policy recommendations are not based on individual country circumstances, but rather are based upon the OECD framework. In this context, the following section presents the theoretical background. In the third section, recent developments in the literature on the subject are reviewed. In Section 4, the data and sample set used in the empirical part are described, along with the empirical plan. Section 5 presents the findings. The last section concludes.

2. Theoretical Background

International trade is viewed as the primary driver of economic growth by the classical economists. Factors such as specialization, division of labor, and economies of scale in production based on comparative advantages are responsible for this phenomenon (Aditya and Acharyya, 2013). While some economists, such as Chenery (1979), support structuralism in development economics, they are of the opinion that this view presents a controversy for developing countries. Their argument is that developing countries have an export basket based on primary commodities during the early stages of development. Consequently, trade structure depending on comparative advantage leads to terms of trade changes, particularly to the detriment of agricultural exporters, and these countries suffer trade losses. To remedy this situation, developing countries should diversify their export basket, i.e., reduce the proportion of

primary goods and increase the proportion of manufactured goods. Also, the new growth theorists such as Romer (1990) and Aghion and Howitt (1998) emphasize both the diversification of export baskets as well as the improvement of the quality and value-added of commodities.

Export diversification means supplying a wider range of commodities to global markets, rather than concentrating on one or a few products and exporting them extensively. It is not the volume of trade but the number of products in the export basket that increases (Meng et al., 2022). Export diversification contributes significantly to a country's prosperity in two ways. First, a limited range of specialized commodities renders a nation more susceptible to exogenous shocks. This implies a reversal in the terms of trade between developing countries and developed countries. Diversification of the export basket involves a degree of compensation between the changes in the world price of goods. The prices of the country's export commodities remain stable. Accordingly, export returns can grow in the long run (Aditya and Acharyya, 2013). The second aspect relates to the commodities included in the export basket. For instance, the high value-added of manufactured goods exported by China is the main driver for its export performance, according to Rodrik (2006). Hence, economic growth is accelerated when high-productivity commodities are exported. Besides providing economic benefits, export diversification can affect the quality of the environment as well (Alhassana et al., 2020). Diversifying export baskets to include commodities that are less resource intensive, environmentally friendly, and eco-innovative facilitates the reduction of negative impacts on the environment (Ali et al., 2022).

There is no single factor that can be attributed to the reduction of pollution in a country or group of countries. Globalization, economic growth, and international trade are complex factors that affect the quality of the environment. Theory can simplify and explain these complex factors. There are usually three different effects responsible for these factors, namely the scale effect, the composition effect, and the technical effect (Antweiler et al., 2001; Sun et al., 2022). According to Sun et al. (2022), the OECD's share of total GHG emissions has a downward trend as the sum of the compositional and the technical effects is greater than the scale effects.

The scale effect suggests that production and environmental degradation are positively related. There was a traditional assumption that there was a linear relationship between the two variables prior to the 1990s. As an alternative approach, the Environmental Kuznets Curve (EKC) was introduced in the mid-1990s by Grossman and Krueger (1995). In this view, a country's environmental degradation increases at an early stage of economic growth. Once a certain threshold has been reached in terms of growth, environmental degradation begins to diminish. By utilizing the CO2 emission model, the results of this analysis suggest that countries with high incomes are more likely to undergo the transition to an environmentally sensitive economic structure as their economies grow. However, this mechanism does not emerge on its own but is triggered by the demands of individuals and the implementation of environmentally sensitive policies by governments (Gozgor and Can, 2016; Sun et al., 2022). EKC is considered as the most popular and researched hypothesis for many years. Nevertheless, some studies have also demonstrated that the EKC is not applicable (Lin et al., 2016; Wang and Ye, 2017, etc.).

The composition effect can be attributed to the structure of the country's industrial sub-sectors. The agricultural, knowledge-based, and technology-based service sectors have a smaller impact on the environment than heavily polluting sectors such as steel and petrochemicals. The technical effect occurs when technological advances lead to emission reductions (Sun et al., 2022). For instance, Shapiro and Walker (2018) identify technological change in the production structure as a source of emission reductions in the US. In fact, the issue of environmental pollution we are discussing today is the result of a long-term nexus of the relationship between growth, trade, and globalization.

The inelasticity and instability of world demand pose a challenge for countries dependent on commodities for exports or whose export basket is narrow. It is economically sound to diversify exports to avoid this situation. The efficacy of this policy depends on the country's high international competitiveness (Hesse, 2008). The competitiveness of countries increases as they become more integrated into the global economy. In other words, as their capacity for economic globalization

increases, their competitiveness increases as well. Economic globalization is a phenomenon that is occurring throughout the world, increasing economic integration, and enhancing border transparency. Due to the mobility of commodities and financial capacity, the argument that this process would bring prosperity to countries is based on the view that knowledge, technology, and savings would be utilized more efficiently. Despite this argument, there is no consensus in the literature regarding the relationship between economic globalization and environmental degradation (Gaiesa et al., 2022). Yet, as developing countries strive to grow economically and increase their GDP per capita, access to international markets and the supply of different commodities is critical (Eicher and Kuenzel, 2016; Hummels and Klenow, 2005; Kaitila, 2019).

Both developed and developing countries are members of the OECD. The challenge of ensuring that countries in both groups minimize environmental damage while increasing their prosperity appears daunting. Theory, however, suggests that environmentally friendly technology may be able to provide a solution. Several technological advances have been undertaken in recent years with the aim of reducing GHG emissions in an innovative manner. By doing so, GHGs are reduced during production in sectors such as construction, industry, and agriculture. The development of these technological advances, known as eco-innovation, is sometimes driven by economic factors instead of environmental ones. Regardless, any innovation that reduces the amount of pollution in the environment while ensuring efficient use of resources is favorable to the environment (Puertas and Marti, 2021).

3. Literature Review

Recent research has focused more attention on the relationship between growth, development, and the environment because of the increased environmental damages caused by economic activities. Particularly since the 1990s, a new wave of globalization has enabled economies to undergo substantial transformations. In many studies, the link between economic globalization and GHG emissions, such as carbon dioxide, has been examined to determine its direction and extent. Even though these studies have covered various periods and been based on different methods, they have not been able to reach a consensus. According to some studies, economic globalization negatively impacts carbon dioxide emissions and leads to environmental degradation (Jahanger, 2022; Lv and Xu, 2019, etc.). However, some studies such as Erdoğan et al. (2021) state that economic globalization results in a better-quality and more sustainable environment. For instance, Zaidi et al. (2019) examined the effects of financial development and globalization on CO2 levels in Asian countries. They concluded that as globalization and financial development increased, environmental degradation levels decreased. Awan et al. (2020) found the same result in his study of MENA countries that analyzed the period 1971-2015. On the other hand, Haseeb et al. (2018) examined the impact of financial development, energy use, globalization, and urbanization on carbon emissions in BRICS countries. Globalization had no effect on environmental pollution in these countries according to the study covering the years 1995-2014.

A pioneering study examining the link between economic growth and environmental damage was Grossman and Krueger (1995), which introduced the EKC approach. As mentioned above, Antweiler et al. (2001) identified the scale effect, composition effect, and technical effect. This study concluded that international trade could harm the environment in developed countries while improving the quality of the environment in developing countries. In later studies, it was discovered that trade has devastating effects on the environment. International trade results in increased production and energy consumption, which in turn leads to an increase in hazardous waste being disposed of in the environment. Additionally, trade increases the use of resources. This increases the pressure on agricultural land as well as production choices. The degradation of the environment is therefore likely to occur because of trade growth based on traditional production structures (Ali et al., 2022).

However, it is questionable whether this relationship is linear and continuous. For example, Ahmed et al. (2016) focused on the causal relationship between trade openness, CO2 emissions, and energy consumption for newly industrializing countries from 1970 to 2013. They found that there is a

unidirectional and positive causal relationship between environmental pollution and trade openness in the short run. Moreover, growth and trade openness result in a reduction in environmental degradation in the long run.

It is also important to examine the composition of the export basket in addition to trade openness. As a result of export diversification in Asia and Latin America over the 1980-2003 period, Agosin (2009) found that part of the GDP per capita growth was attributed to this; in fact, the number of different commodities contained in the export basket was a major determinant of the difference between countries' growth performance. Hesse (2008) analyzed the period between 1961 and 2000 and concluded that export diversification and economic growth were not linearly related. Thus, developing countries experienced economic growth as a result of diversifying their export baskets, whereas developed countries experienced economic growth as an outcome of specialization, i.e. narrowing their export baskets. Aditya and Acharyya (2013) examined the relationship between export diversification and economic growth for 65 countries between 1965 and 2005. Based on the findings of this study, export diversification had a nonlinear and positive relationship with the country's greater share of the export market for the relevant commodity. There was a direct correlation between the current level of export diversification of a country and its decision to diversify or specialize. Furthermore, the sophistication of the exported commodities was just as important as the volume of exports.

Various studies have explored the link between export diversification and the environment. According to some studies, expanding the export basket results in increased environmental pollution (Can et al., 2020; Fang et al., 2019; Mania, 2020; Wang et al., 2020, etc.)[2]. Nevertheless, some studies have found that export diversification improves the quality of the environment. Among these studies, the following are a few recent examples.

According to Gozgor and Can (2016), export diversification contributed to a reduction in CO2 emissions for Turkish enterprises from 1971 to 2010 which means that diversifying export basket in the long run resulted in lower CO2 emissions. Based on a panel data analysis of 19 industrialized economies from 1962 to 2010, Apergis et al. (2018) examined the relationship between CO2 emissions and export diversification. According to them, export diversification decreased emissions associated with the EKC curve.

In their study, Liu et al. (2018) examined how export diversification affected Korea, Japan, and China's ecological footprints between 1990 and 2013. They observed an inverted U-shaped curve except for China. Furthermore, Liu et al. (2019) analyzed the relationship between trade, export diversification, and CO2 emissions in 125 countries over the period 2000-2014. Researchers found that poor countries had a U-shaped connection between development and carbon emissions. In the study, it was emphasized that there was an inverted-U shape in OECD countries as well as in all 125 countries, which supports the EKC hypothesis.

In their study, Alhassana et al. (2020) researched the link between trade and the environment in 79 countries between 2008 and 2018. The results indicated that trade boosts environmental pollution, although the negative impacts gradually decrease as income levels increase. Bashir et al. (2020) showed that export diversification reduced the energy intensity of 29 OECD countries for the years 1990 to 2015. Shahzad et al. (2020) examined the relationship between export baskets and carbon emissions in developed and developing countries. Using data from 63 countries between 1971 and 2014, the study found a positive link between export diversification and greenhouse gas emissions. It was evident that this relationship weakens with an increase in the level of development in a country. According to Zafar et al. (2022), remittances, export diversification, education and carbon emissions were related in 22 countries. The findings of the study using the cointegration method indicated that export diversification improves the quality of the environment.

[2] See Saboori et al. (2022) for a detailed literature table.

In the literature, there is no consensus concerning the relationship between trade, export diversification, and environmental degradation. Several studies, most using panel data methods, have demonstrated a positive correlation between export diversification and environmental pollution. Some studies have suggested that an expansion of the export basket will result in an improvement in environmental quality. Researchers have used the Theil index to evaluate export diversification but have misinterpreted the findings by ignoring its negative sign. Moreover, many studies have only examined CO2, which is only one of the GHGs. To our knowledge, no study has examined export diversification in OECD countries by utilizing Finger-Kreinin' index. As a result, this study extends the existing model to include a broader set of pollutants, GHG emissions, in comparison with other studies in the literature. In this study, we empirically examine the effects of economic globalization and export diversification on GHG emissions in OECD countries from 1995 to 2019 by using panel data methodology.

4. Data and Empirical Framework

The study aims to empirically analyze the impact of economic globalization and export diversification on GHG emissions. It encompasses countries that are members of the OECD. A regression model has been constructed to examine the relevant relationship over the period from 1995 to 2019. The analysis includes 27 out of the 38 OECD member countries to maximize the dataset and ensure panel data balance.

In this study, GHG emissions were employed as the dependent variable. The unit of measurement for the emission data obtained from the OECD database is a thousand tons of CO2 equivalent. This variable includes not only CO2 but all GHGs as well. There are two independent variables: the economic globalization index and the export diversification index.

To measure economic globalization, the KOF Globalization Index database was used. This database is a composite index and consists of sub-indices. In Table 1, the variables and their weights used to construct the economic globalization index are presented. The KOF Globalization Index has been revised to separate variables based on de facto and de jure trade factors. A key reason for the distinction is that statistics on paper (de facto) and policies enacted and implemented (de jure) produce different results. More specifically, the definition of de facto trade is based on the trade in goods and services. Tariffs, taxes, and restrictions on trade are part of the de jure trade (Gygli et al., 2019). In this study, economic globalization index, de jure is used as an independent variable. There are two reasons for the preference: i) de facto variables are prone to multicollinearity problem, and ii) de jure variables are more compatible with the willingness of countries to integrate into the global economy.

Table 1. Weights of Components in KOF Globalization Indices in 2021

Indices	**Components**		**Weights**
Trade Globalization Index, *de jure*			50
	Trade regulations	*26.8*	
	Trade taxes	*28.1*	
	Tariffs	*27.1*	
	Trade agreements	*18.0*	
Financial Globalization Index, *de jure*			50
	Investment restrictions	*30.2*	
	Capital account openness	*39.0*	
	International investment agreements	*30.8*	
Economic Globalization, *de jure*			**100**

Source: Gygli et al. (2019).

The export diversity index obtained from the UNCTAD database is the second independent variable used in this study. This diversification index is based on Finger and Kreinin (1979)'s trade similarity index. Based on the absolute bias of a country's trade structure from the global trade environment, the index is calculated. Calculation of the index is as follows (UNCTAD, 2023):

$$s_j = \frac{\Sigma_i \left| h_{ij} - h_i \right|}{2}$$

where s_j is diversification index, h_{ij} is share of good i in total exports or imports of country j, and h_j is share of good i in total exports or imports. Diversification indexes range from 0 to 1. When the value is closer to 1, it indicates a greater deviation from the world pattern. The variables of trade openness and GDP growth were also used as control variables. The database of World Development Indicators (WDI) of the WB was utilized to gather these two variables. Trade openness is calculated as the sum of export and import volumes as a percentage of gross domestic product. GDP growth is measured in annual percentages. Table 2 shows the variables that are included in the empirical model.

Table 2. Summary of Variables

Symbol	Description	Definitions /Measures	Source	Positioning	Expected Sign
lngge	Logarithmic form of greenhouse gas emissions	Total greenhouse gas emissions (kt of CO2 equivalent)	OECD	Dependent	
di	Product diversification index of exports	$0 \leq di \leq 1$	UNCTAD	Independent (Focus variable)	(-)
kofeg	KOF economic globalization index, *de jure*	$0 \leq kofeg \leq 100$	KOF	Independent (Focus variable)	(-)
gr	GDP growth	annual, %	WDI	Control variable	(+)
trade	Trade openness rate	Percentage of GDP	WDI	Control variable	(+)

There are 25 years of data for 27 countries in the data set, which is structured as a balanced panel with no missing data. Thus, the sample consists of 675 observations. The descriptive statistics are in Table 3. As OECD includes countries of different income groups, the range of the variables differ widely. Also, Table 4 presents the correlation matrix.

Table 3. Descriptive Statistics

Variable	Obs.	Mean	St. Dev.	Min.	Max.
lngge	675	12.119	1.35	9.058	15.832
di	675	0.437	0.119	0.228	0.717
kofeg	675	82.465	8.429	48.408	96.864
gr	675	2.455	2.705	-10.149	24.37
trade	675	98.584	57.309	16.39	377.843

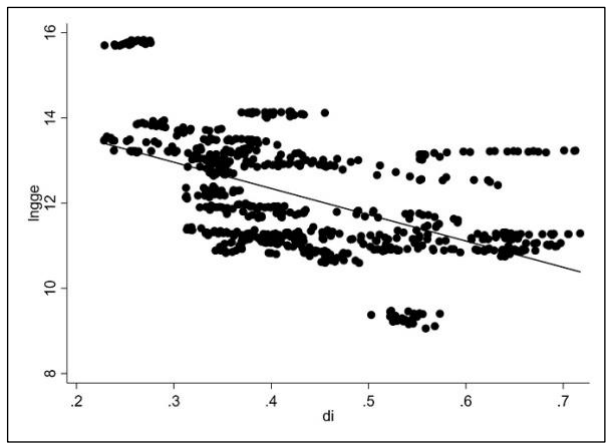
Note. Obs: number of observations, St. Dev.: standard deviation, Min.: minimum value, Max: maximum value.

Table 4. Correlation Matrix

	lngge	di	kofeg	gr	trade
lngge	1.000				
di	-0.544	1.000			
kofeg	-0.267	-0.224	1.000		
gr	-0.077	0.165	-0.014	1.000	
trade	-0.055	0.159	-0.233	-0.111	1.000

Additionally, Figure 1 is presented in conjunction with the correlation matrix. Figure 1 represents a scatter plot of the link between GHG emissions and export diversification based on the panel data set. Two variables exhibit a negative relationship.

Figure 1. The Relationship between GHG Emissions and Export Diversification Index



In this study, a functional model with the following structure was established:

$$lngge_t = f(lnggew_{t-1},\ di_t, kofeg_t, gr_t,\ trade_t)$$

where 'lngge' represents the dependent variable, and 'lnggew' is for lagged value of the dependent variable while 'di' and 'kofeg' serve as the focal variables, and 'gr' and 'trade' are considered control variables within the function. The inclusion of the export diversification index in the model aligns with prior research by Ahmed et al. (2017) and Halicioglu (2009), who have previously identified a significant relationship between the composition of export baskets and environmental pollution. Additionally, the KOF economic globalization index was incorporated into the model, in line with findings from Le and Ozturk (2020).

To examine the effects of export basket and economic globalization on GHG emissions, the following regression equation was specified:

$$lngge_{it} = \beta_0 + \beta_1 lngge_{it-1} + \beta_2 di_{it} + \beta_3 kofeg_{it} + \beta_4 trade_{it} + \beta_5 lngdp_{it} + \varepsilon_{it}, \quad \text{(Eq. 1)}$$

Three distinct model specifications were estimated based on the regression equation's structure. Model 1 includes 'lnggew', 'di', and 'kofeg' as independent variables. Model 2 expands upon this by incorporating 'lnggew', 'di', 'kofeg', and 'gr' as independent variables. Model 3 represents a comprehensive regression model encompassing all variables, as defined in equation Eq. 1.

It is generally assumed that error terms in panel data structures comprising different units are independent from each other; however, this assumption is often incorrect. Numerous analyses have demonstrated that the error terms of these units are simultaneously correlated. Consequently, it becomes imperative to check the existence of cross-sectional dependence (CSD) among these units (Yerdelen Tatoğlu, 2021: 257). There are three primary causes of CSD: unobserved components, common shocks, and residual interdependency (Hao et al., 2021). To ascertain the existence of dependence among cross-sectional units, we employed the Breusch-Pagan Lagrange Multiplier (LM) tests (Breusch and Pagan, 1980).

Following the analysis for CSD, we examined the stationarity of the series. If there is no CSD, 1st generation unit root tests are used. However, in the presence of CSD, 2nd generation unit root tests are preferred over the 1st generation ones. Given that cross-sectional independence was rejected in this study, we applied the Cross-Sectionally Augmented IPS (CIPS), which is a 2nd generation unit root test developed by Pesaran (2007). As the dependent variable and some independent variables are stationary at

I(1), while one independent variable is stationary at I(0), we utilized the Dynamic Common Correlated Effects (DCCE) test developed by Chudik and Pesaran (2015) as an estimator.

5. Empirical Results

As an initial step in the analysis, it is required to examine the existence of CSD among the units in the panel data. Various tests are available for assessing CSD, and for this study, we have chosen to employ the Breusch and Pagan (1980) tests. In this test, H_0 posits the absence of CSD. The outcomes of the CSD test are presented in Table 5. These results reveal that the p-values associated with the statistics are less than 0.05, leading us to reject the null hypothesis, which implies the existence of CSD among the units. In practical terms, this signifies that an external shock affecting one country can also have an impact on others within the same group. These findings hold consistently for countries that belong to the same organization, the OECD, and are closely integrated into global markets.

Table 5. Breusch-Pagan LM Test Results

Model	**Test Stat.**	**p - Value**
Model 1	3479.572***	0.000
Model 2	3372.928***	0.000
Model 3	3088.802***	0.000

Note. ***, **, * mean significant at the 1%, 5% and 10% levels, respectively.

To address CSD among the units, a panel stationarity test was conducted using CIPS, a 2nd generation unit root test. The summarized results are presented in Table 6. The findings indicate that several independent variables, along with the dependent variable, exhibit stationarity in their first differences, while one independent variable is stationary at the level.

Table 6. Second-Generation Unit Root Test Results

	C		**CandT**	
	Level	Difference	Level	Difference
	Test Stat.	**Test Stat.**	**Test Stat.**	**Test Stat.**
lngge	-1.966	-2.436***	-2.276	-2.677*
di	-1.327	-2.617***	-1.943	-2.733**
kofeg	-2.028	-2.355***	-1.808	-2.789**
gr	-2.511	-2.926***	-2.702	-2.839**
trade	-1.766	-2.056	-1.784	-2.145

Note. ***, **, * mean significant at the 1%, 5% and 10% levels, respectively. C: constant, CandT: constant and trend.

In the final stage of analysis, the DCCE estimator was employed to assess the relationships. This estimator considers CDS, enabling the slope coefficient to vary across different cross-sections. The DCCE estimator with lagged dependent variable is applicable in cases where N > T and T > N. All three models are in Table 7. Model 1 includes only the focal variables, while both Models 2 and 3 incorporate control variables. All three models reveal a statistically significant positive correlation between lagged value of GHG emission and GHG emissions which is consistent with the fact that the current amount of pollution is not independent of the amount in the previous period. Further, the full model showed that the export diversification index has a significant negative impact on GHG emissions which is consistent with Apergis et al., (2018), Gozgor and Can (2016) and Zafar et al. (2022). According to this analysis, an expansion of the export basket in OECD countries leads to a reduction in GHG emissions. However, the

results show that the *kofeg* and control variables do not exhibit statistical significance. The result on *kofeg* is consistent with Haseeb et al. (2018).

Table 7. Estimation Results

	(1)	**(2)**	**(3)**
$lnggw_{t-1}$	0.723***	0.742***	0.398***
	(0.143)	(0.139)	(0.085)
di	-0.192	-0.191	-0.244**
	(0.260)	(0.253)	(0.106)
kofeg	0.000	0.000	-0.001
	(0.002)	(0.002)	(0.001)
gr		0.002	0.002
		(0.003)	(0.001)
trade			-0.000
			(0.000)
Constant	-5.153***	-3.082**	-1.388
	(1.385)	(1.391)	(1.632)
Observations	648	648	648
R-squared	0.257	0.259	0.585
Number of groups	27	27	27

Note. ***, **, * mean significant at the 1%, 5% and 10% levels, respectively. Standard errors are in parentheses.

6. Conclusion

After the first Industrial Revolution, economies experienced unprecedented growth. The energy transformation was the primary driver of this process. Society's lives have been dramatically altered by factors such as mass production, technological advancements, the intensive use of fossil resources, and expanding international trade. The end of the golden age in the 1970s, however, revealed that we also caused serious environmental degradation. It took a slow process of international consensus to bring about the Paris Climate Agreement. Although a global partnership is not yet at the desired level, the steps taken so far are encouraging. The importance of joining this broad partnership has now become imperative for all countries. The OECD plays an important role in this regard. Over half of the total trade volume and roughly a third of its greenhouse gas emissions are attributed to the OECD.

A growing international trade is also an indicator that economies are becoming more globalized and that countries are being integrated into international markets. In the literature, there have been many studies examining the effects of globalization and trade on environmental quality. A variety of methods have been used in these studies to examine different countries or country groups. The findings and policy recommendations have varied based on the period studied and the variables used. Some researchers have examined only developed or developing countries, while others have analyzed groups that include both. We are unable to comment on whether these studies have been taken into consideration or implemented. Nonetheless, the emergence of global partnerships, as well as the fact that our world is becoming warmer and facing the threat of climate change, suggest that some theories or policies ought to be reconsidered. Therefore, it is highly questionable that the economic model based on the principles of comparative advantage and specialization, which has brought our world into the face of the current global warming threat, is still shown as a way out in some studies, let alone proposed to be transformed.

This study examines the influences of economic globalization and export diversification variables on greenhouse gas emissions in OECD countries for the period 1995-2019. A balanced panel of 27 OECD countries with complete data for the relevant period is used in the study so that balanced panel data can be used. The US emits the most pollutants among these countries. All members except Türkiye have decreased their greenhouse gas emissions in the following years. Clearly, this decrease indicates that the organization has taken steps to reduce pollutants and participates in global partnerships. It may be possible to support these efforts through the expansion of the export basket and the development of a

more integrated global market. Hence, the study tests the hypothesis that economic globalization and export diversification negatively impact greenhouse gas emissions, i.e. improve environmental quality. The contribution of this study includes the employment of GHG emissions instead of CO_2 emissions for OECD countries, the use of the *de jure* part of the economic globalization index, the application of the Finger-Krenin's index as an export diversification index, and the presentation of a policy recommendation on a community basis rather than on an individual basis.

Based on the study's results, the pollution level is affected by its previous level, as expected. On the other hand, the globalization index is not statistically significant. This point gives rise to the possibility of challenging the de jure trade globalization index as well as the de jure financial globalization index that comprises the economic globalization index. The structure of OECD countries is heterogeneous. As a result, each country's trade regulations, customs duties, and capital liberalization rules may produce complex effects. An analysis of these factors separately may be the subject of another study. Further, neither growth nor trade openness are found to be statistically significant in the empirical findings.

Also, this study finds that the diversification of export baskets is a factor that have contributed to improving environmental quality. This finding cannot be interpreted as a continuation of traditional energy use and production methods. Over the past decade, developments such as renewable energy and green transformation in production have initiated a new process. This process may be referred to as the green economy. Green economies are characterized by environmentally friendly technological developments. This knowledge cluster has also grown through the diffusion of technology due to the convergence of countries through globalization. An increase in eco-innovative technologies leads both to green transformations in the economy and to new innovations. We can utilize energy and natural resources more efficiently and reduce the degradation of the environment through eco-innovative technological advancements. The advancements should be spread across all sectors, not just concentrated in a few. In other words, for the OECD as an organization to improve environmental quality depends on policy changes such as member countries expanding eco-innovative initiatives and technologies in all sectors, not only in sectors where they have a comparative advantage and expanding their export baskets in response to decreasing energy intensity and production costs. Otherwise, the negative relationship between export diversification and greenhouse gas emissions will not be able to benefit our world positively.

Furthermore, it is important to consider a less energy-intensive structure to produce goods and services before expanding the export basket. Providing for this need supports the transformation of the energy sector as well as enabling the development of innovative production techniques. On the demand side, the preference for more environmentally friendly products contributes to the acceleration of this change. Alternatively, consumers may prefer goods that are produced in their local area to protect our planet. According to this approach, international trade should be based on a principle of *more responsible consumption* rather than *more consumption*, in order to benefit both humanity and our planet in the long run.

References

Aditya, A., and Acharyya, R. (2013). Export diversification, composition, and economic growth: Evidence from cross-country analysis. *The Journal of International Trade and Economic Development, 22*(7), 959-992. https://doi.org/10.1080/09638199.2011.619009

Aghion, P., and Howitt, P. (1998). *Endogenous growth theory*. MIT Press.

Agosin, M. R. (2009). Export diversification and growth. *Cepal Review, 97*, 115-131.

Ahmed, K., Bhattacharya, M., Shaikh, Z., Ramzan, M., and Ozturk, I. (2017). Emission intensive growth and trade in the era of the association of Southeast Asian Nations (ASEAN) integration: An empirical investigation from ASEAN-8. *Journal of Cleaner Production, 154*, 530-540. https://doi.org/10.1016/j.jclepro.2017.04.008

Ahmed, K., Shahbaz, M., and Kyophilavong, P. (2016). Revisiting the emissions-energy-trade nexus: Evidence from the newly industrializing countries. *Environmental Science and Pollution Research, 23*, 7676-7691. https://doi.org/10.1007/s11356-015-6018-x

Alhassana, A., Usman, O., Ikea, G. N., and Sarkodie, S. A. (2020). Impact assessment of trade on environmental performance: Accounting for the role of government integrity and economic development in 79 countries. *Heliyon, 6*(9), 1-10. https://doi.org/10.1016/j.heliyon.2020.e05046

Ali, S., Can, M., Shah, M. I., Jiang, J., Ahmed, Z., and Murshed, M. (2022). Exploring the linkage between export diversification and ecological footprint: Evidence from advanced time series estimation techniques. *Environmental Science and Pollution Research, 29*, 38395–38409. https://doi.org/10.1007/s11356-022-18622-3

Antweiler, W., Copeland, B. R., and Taylor, M. S. (2001). Is free trade good for the environment? *American Economic Review, 91*(4), 877-908.

Apergis, N., Jebli, M. B., and Youssef, S. B. (2018). Does renewable energy consumption and health expenditures decrease carbon dioxide emissions? Evidence for Sub-Saharan Africa Countries. *Renewable Energy, 127*, 1011-1016. https://doi.org/10.1016/j.renene.2018.05.043

Awan, A. M., Azam, M., Saeed, I. U., and Bakhtyar, B. (2020). Does globalization and financial sector development affect environmental quality? A panel data investigation for the Middle East and North African countries. *Environmental Science and Pollution Research, 27*, 45405-45418. https://doi.org/10.1007/s11356-020-10445-4

Bashir, M. A., Sheng, B., Doğan, B., Sarwar, S., and Shahzad, U. (2020). Export product diversification and energy efficiency: Empirical evidence from OECD countries. *Structural Change and Economic Dynamics, 55*, 232-243. https://doi.org/10.1016/j.strueco.2020.09.002

Breusch, T. S., and Pagan, A. R. (1980). The lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies, 47*(1), 239-253. https://doi.org/10.2307/2297111

Can, M., Dogan, B., and Saboori, B. (2020). Does trade matter for environmental degradation in developing countries? New evidence in the context of export product diversification. *Environmental Science and Pollution Research, 27*, 14702–14710. https://doi.org/10.1007/s11356-020-08000-2

Chenery, H. B. (1979). *Structural change and development policy.* Oxford University Press.

Chudik, A., and Pesaran, M. H. (2015). Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics, 188*(2), 393-420. https://doi.org/10.1016/j.jeconom.2015.03.007

Eicher, T. S., and Kuenzel, D. J. (2016). The elusive effects of trade on growth: Export diversity and economic take-off. *Canadian Journal of Economics, 49*(1), 264-295. https://doi.org/10.1111/caje.12197

Erdoğan, S., Çakar, N. D., Ulucak, R., Danish, and Kassouri, Y. (2021). The role of natural resources abundance and dependence in achieving environmental sustainability: Evidence from resource-based economies. *Sustainable Development, 29*(1), 143-154. https://doi.org/10.1002/sd.2137

Fang, J., Gozgor, G., Lu, Z., and Wu, W. (2019). Effects of the export product quality on carbon dioxide emissions: evidence from developing economies. *Environmental Science and Pollution Research, 26*, 12181–12193. https://doi.org/10.1007/s11356-019-04513-7

Finger, J. M., and Kreinin, M. E. (1979). A measure of `export similarity' and its possible uses. *The Economic Journal, 89*(356), pp. 905-912. https://doi.org/10.2307/2231506

Gaiesa, B., Nakhli, M. S., and Sahut, J.-M. (2022). What are the effects of economic globalization on CO2 emissions in MENA countries? *Economic Modelling, 116*, 1-14. https://doi.org/10.1016/j.econmod.2022.106022

Gozgor, G., and Can, M. (2016). Export product diversification and the environmental Kuznets curve: Evidence from Turkey. *Environmental Science and Pollution Research, 23*, 21594–21603. https://doi.org/10.1007/s11356-016-7403-9

Grossman, G. M., and Krueger, A. B. (1995). Economic growth and the environment. *The Quarterly Journal of Economics, 110*(2), 353-377. https://doi.org/10.2307/2118443

Gygli, S., Haelg, F., Potrafke, N., and Sturm, J.-E. (2019). The KOF globalisation index – revisited. *The Review of International Organizations, 14*, 543–574. https://doi.org/10.1007/s11558-019-09344-2

Halicioglu, F. (2009). An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy, 37*(3), 1156-1164. https://doi.org/10.1016/j.enpol.2008.11.012

Hao, L.-N., Umar, M., Khan, Z., and Ali, W. (2021). Green growth and low carbon emission in G7 countries: How critical the network of environmental taxes, renewable energy and human capital is? *Science of The Total Environment, 752*. https://doi.org/10.1016/j.scitotenv.2020.141853

Haseeb, A., Xia, E., Danish, Baloch, M. A., and Abbas, K. (2018). Financial development, globalization, and co2 emission in the presence of EKC: Evidence from BRICS countries. *Environmental Science and Pollution Research, 25*, 31283-31296. https://doi.org/10.1007/s11356-018-3034-7

Hesse, H. (2008). *Export diversification and economic growth.* The International Bank for Reconstruction and Development / The World Bank.

Hummels, D., and Klenow, P. J. (2005). The variety and quality of a nation's exports. *American Economic Review, 95*(3), 704-723. https://doi.org/10.1257/0002828054201396

Jahanger, A. (2022). impact of globalization on CO2 emissions based on EKC hypothesis in developing world: The moderating role of human capital. *Environmental Science and Pollution Research, 29*, 20731-20751. https://doi.org/10.1007/s11356-021-17062-9

Kaitila, V. (2019). Export product range and economic growth in the EU countries. *The World Economy, 42*(3), 711-737. https://doi.org/10.1111/twec.12715

Le, H. P., and Ozturk, I. (2020). The impacts of globalization, financial development, government expenditures, and institutional quality on CO2 emissions in the presence of environmental Kuznets curve. *Environmental Science and Pollution Research, 27*, 22680-22697. https://doi.org/10.1007/s11356-020-08812-2

Levin, K., Cashore, B., Bernstein, S., and Auld, G. (2012). Overcoming the tragedy of super wicked problems: Constraining our future selves to ameliorate global climate change. *Policy Sciences, 45*, 123-152. https://doi.org/10.1007/s11077-012-9151-0

Lin, B., Omoju, O. E., Nwakeze, N. M., Okonkwo, J. U., and Megbowon, E. T. (2016). Is the environmental Kuznets curve hypothesis a sound basis for environmental policy in Africa? *Journal of Cleaner Production, 133*, 712-724. https://doi.org/10.1016/j.jclepro.2016.05.173

Liu, H., Kim, H., and Choe, J. (2019). Export diversification, CO2 emissions and EKC: Panel data analysis of 125 countries. *Asia-Pacific Journal of Regional Science, 3*, 361-393. https://doi.org/10.1007/s41685-018-0099-8

Liu, H., Kim, H., Liang, S., and Kwon, O.-S. (2018). export diversification and ecological footprint: A comparative study on EKC theory among Korea, Japan, and China. *Sustainability, 10*, 1-12. https://doi.org/10.3390/su10103657

Lv, Z., and Xu, T. (2019). Trade openness, urbanization and CO2 Emissions: Dynamic panel data analysis of middle-income countries. *The Journal of International Trade and Economic Development, 28*(3), 317-330. https://doi.org/10.1080/09638199.2018.1534878

Mania, E. (2020). Export diversification and CO2 emissions: An augmented environmental Kuznets curve. *Journal of International Development, 32*(2), 168-185. https://doi.org/10.1002/jid.3441

Meng, Y., Wu, H., Wang, Y., and Duan, Y. (2022). International trade diversification, green innovation, and consumption-based carbon emissions: The role of renewable energy for sustainable development in BRICST countries. *Renewable Energy, 198*, 1243-1253. https://doi.org/10.1016/j.renene.2022.08.045

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics, 22*(2), 265-312. https://doi.org/10.1002/jae.951

Puertas, R., and Marti, L. (2021). Eco-innovation and determinants of GHG emissions in OECD countries. *Journal of Cleaner Production, 319*, pp. 1-8. https://doi.org/10.1016/j.jclepro.2021.128739

Rodrik, D. (2006). What's so special about China's Exports? *China and World Economy, 14*(5), 1-19. https://doi.org/10.1111/j.1749-124X.2006.00038.x

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy, 98*(5), 71-102.

Saboori, B., Zaibet, L., and Boughanmi, H. (2022). Export diversification, energy consumption, economic growth and environmental degradation: Evidence from Oman. *International Journal of Ambient Energy, 43*(1), 8486-8504. https://doi.org/10.1080/01430750.2022.2091026

Shahzad, U., Ferraz, D., Doğan, B., and Rebelatto, D. A. (2020). Export product diversification and CO2 emissions: contextual evidences from developing and developed economies. *Journal of Cleaner Production, 276*. https://doi.org/10.1016/j.jclepro.2020.124146

Shapiro, J. S., and Walker, R. (2018). Why is pollution from US manufacturing declining? The roles of environmental regulation, productivity, and trade. *American Economic Review, 108*(12), 3814-3854.

https://doi.org/10.1257/aer.20151272

Sun, X., Dong, Y., Wang, Y., and Ren, J. (2022). Sources of greenhouse gas emission reductions in OECD countries: Composition or technique effects. *Ecological Economics, 193*, 1-12. https://doi.org/10.1016/j.ecolecon.2021.107288

UNCTAD. (2023). *Merchandise: product concentration and diversification indices of exports and imports, Annual*. Retrieved from https://unctadstat.unctad.org/wds/TableViewer/summary.aspx

Wang, L., Chang, H.-L., Rizvi, S. K., and Sari, A. (2020). Are eco-innovation and export diversification mutually exclusive to control carbon emissions in G-7 Countries? *Journal of EnvironmentalManagement,, 270*. https://doi.org/10.1016/j.jenvman.2020.110829

Wang, Z., and Ye, X. (2017). Re-examining environmental Kuznets curve for China's city-level carbon dioxide (CO2) emissions. *Spatial Statistics, 21*, 377-389. https://doi.org/10.1016/j.spasta.2016.09.005

World Bank. (2023a). *GDP (constant 2015 US$)*. Retrieved from World Development Indicators: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD

World Bank. (2023b). *Exports of goods and services (current US$)*. Retrieved from World Development Indicators: https://data.worldbank.org/indicator/NE.EXP.GNFS.CD

World Bank. (2023c). *Total greenhouse gas emissions (kt of CO2 equivalent)*. Retrieved from World Development Indicators: https://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE

Yerdelen Tatoğlu, F. (2021). *Panel veri ekonometrisi: Stata uygulamalı* (Genişletilmiş 6. ed.). Beta Yayıncılık.

Zafar, M. W., Saleem, M. M., Destek, M. A., and Caglar, A. E. (2022). The dynamic linkage between remittances, export diversification, education, renewable energy consumption, economic growth, and CO2 emissions in top remittance-receiving countries. *Sustainable Development, 30*(1), 165–175. https://doi.org/10.1002/sd.2236

Zaidi, S. A., Zafar, M. W., Shahbaz, M., and Hou, F. (2019). Dynamic linkages between globalization, financial development and carbon emissions: Evidence from Asia Pacific economic cooperation countries. *Journal of Cleaner Production, 228*, 533-543. https://doi.org/10.1016/j.jclepro.2019.04.210